

Environmental Effects of Dredging Technical Notes



DREDGED MATERIAL CONTAINMENT AREA MANAGEMENT PRACTICES FOR INCREASING STORAGE CAPACITY

PURPOSE: This technical note describes techniques for managing confined dredged material disposal areas to maximize storage capacity. Management of these disposal facilities is recommended to extend their useful life and, thus, minimize the requirement for additional disposal facilities.

BACKGROUND: Large quantities of sediment are dredged from the navigable waterways of the United States annually and must be placed in an environmentally acceptable manner at a designated disposal site. Confined upland sites and subaqueous disposal sites are most commonly used for disposal of dredged material. Presently about 40 percent of dredged material is placed in upland sites. This material has a high water content upon placement and is often located above the existing groundwater table and can conceivably be dewatered to significantly reduce its volume.

The use of confined disposal sites needs to be optimized to increase the quantity of dredged material that can be stored in a site. The quantity of sediment that can be placed in a containment area is determined by the size of the site, the maximum dike height allowed, and the consistency of the dredged material stored in the site. As consolidation (reduction in volume under load) and desiccation (drying) occur, water is removed from the dredged material and the volume of dredged material (soil plus water) to be stored is reduced. As this water is removed, the consistency of the material changes from a very soft material (almost a viscous fluid) toward firm ground; the ultimate consistency of the dredged material will depend upon the amount of water removed, as well as the properties of the dredged material, the frequency of disposal operations, and the management practices used.

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Introduction

A number of techniques can be used to facilitate management of confined upland dredged material disposal areas for maximum storage capacity and useful life. Some techniques must be applied either during or immediately after dredging operations, while others should continue throughout the drying cycle until a subsequent disposal operation begins. These practices can be applied equally well to disposal sites used independently or in conjunction with other disposal areas. Figure 1 is a schematic diagram of a typical dredged material disposal area.

The management techniques described in this Technical Note apply to containment areas in which clean sediments have been placed. Regarding contaminated sediments, the oxidized conditions which can develop when dredged material is dried can favor increased mobilization and release of contaminants. If contaminated materials are involved, the tradeoffs between the benefits of dewatering

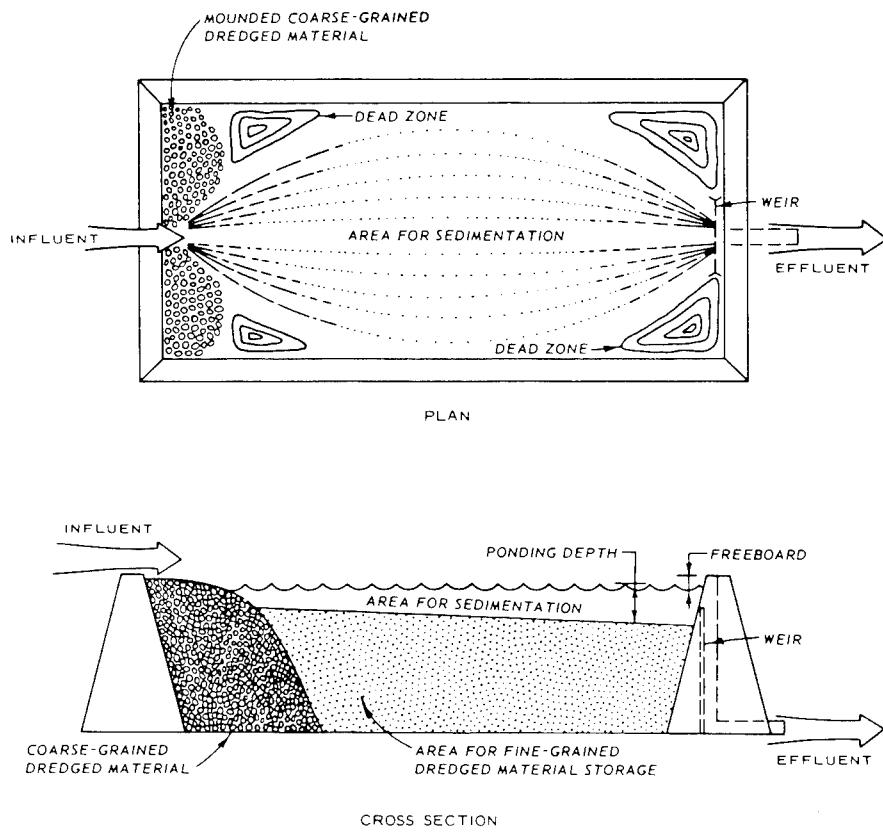


Figure 1. Schematic diagram of an upland dredged material containment area

and drying of the dredged material and the increased potential for contaminant release must be evaluated. If dewatering of contaminated dredged material is to occur, additional constraints on site operation and management may be required.

Management Techniques

The following techniques and procedures should be considered in any comprehensive plan for dredged material containment area management. Use of all techniques is necessary to maximize containment area storage capacity, but the use of any of these procedures will result in some increase in capacity. The benefits gained from site management will depend on which procedures are used and to what degree they are used.

Inflow-outflow locations

Dredged material is usually placed in a confined upland site by hydraulic pipeline dredge, although hopper dredge or barge pumpout may also be used. In either case, the material enters the containment area in the form of a slurry with a concentration of about 150 g/l. As the material is discharged from the pipeline, coarse-grained material will fall out of suspension and form a mound at the discharge point. The remainder of the material (the fine-grained portion) will flow further into the containment area; this material will typically have a surface slope of 0.36V on 100H. Locating the inflow (dredge pipe) and outflow (weir) points at opposite ends of a rectangular disposal area or as far apart as possible in disposal sites of other shapes is, therefore, advisable. A gently and continuously sloping surface will result, which will facilitate later surface water removal. If the inflow point and weirs must be located on the same side of the disposal site, construction of a spur dike (or dikes) to increase settling efficiencies and to avoid later drainage problems should be considered. Figure 2 illustrates the potential drainage problem that often occurs when the inflow and outflow points are not adequately separated.

Surface water ponding

During active dredging and disposal operations, a pond of water should be maintained across the surface of the disposal site. This pond will provide

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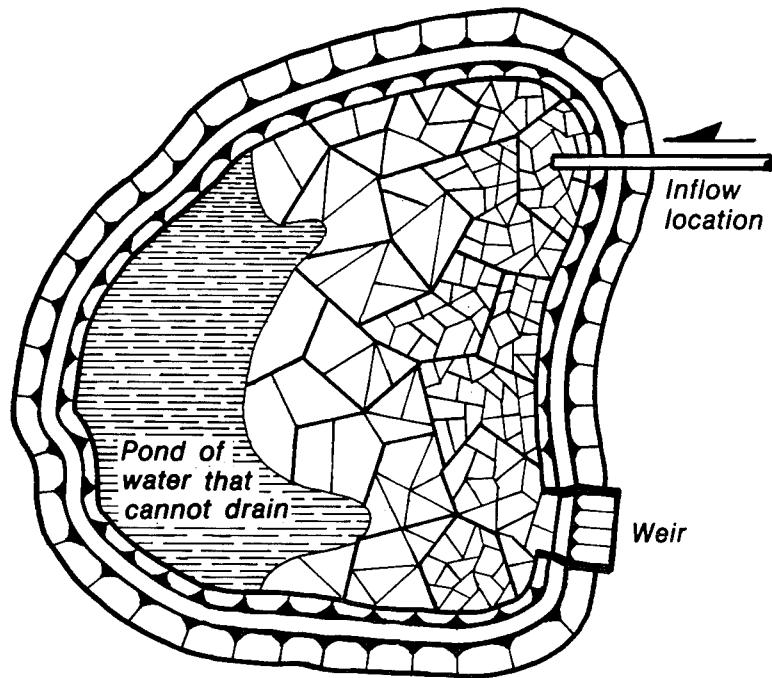


Figure 2. Improper location of inflow point and weir, causing stagnant ponds of water that cannot drain from the site

adequate detention time for sedimentation. A minimum depth of 2 ft of ponded water should be maintained above the solids-water interface.

Immediately after disposal operations are completed, the ponded surface water should be decanted. This can be accomplished by gradual reduction in the weir crest elevation when an adjustable weir is used at the site. The weir crest must be lowered slowly to ensure that acceptable effluent water quality is maintained. When other types of discharge structures are used, the same principle of slow withdrawal should be followed (Headquarters, US Army Corps of Engineers 1987).

Long-term weir operation

After dredging and the decantation of the ponded surface water are completed, site management efforts should be concentrated on maximizing the containment area storage capacity gained from continued consolidation of both the dredged material and the foundation soils and drying of the dredged material. To ensure that precipitation does not result in ponded water, the weir crest elevation must be kept at levels that allow efficient release of surface

runoff. This will require periodic lowering of the weir crest elevation as the dredged material surface settles.

Thin-lift placement

Gains in long-term storage capacity through natural drying processes can also be increased by placing the dredged material in thin lifts. Thin lifts are considered to be those dredged material layers initially not over 3 to 5 ft thick. Thin-lift placement greatly enhances potential gains in storage capacity when active dewatering and disposal area reuse management programs are implemented (Headquarters, US Army Corps of Engineers 1987). Thin lifts may be placed either by limiting the amount of material placed during a given disposal operation or by obtaining a site with larger surface area. Implementing this approach requires careful long-range planning to ensure that the larger land area is used effectively for dredged material dewatering, rather than simply being a containment area whose service life is longer than that of a smaller area.

Surface drainage

Surface drainage facilitates dredged material dewatering by providing rapid removal of precipitation and by shortening the drainage path length within the deposit. The method of drainage most often used in containment areas is progressive surface trenching. This entails creating shallow trenches in the soft dredged material within a few months after the ponded water is removed. Then as the dredged material dries and a thicker surface crust forms, the initial trenches are periodically deepened (Headquarters, US Army Corps of Engineers 1987).

Typically, perimeter trenches are first constructed by draglines working from the retaining dikes or from a berm on the interior of the dikes shortly after the surface water is removed (Benson 1988, Poindexter and Walker 1988). These trenches should be constructed as far into the site as the equipment can reach to minimize future stability problems as the dikes are raised. As the perimeter trenches are created, material removed from the trenches is deposited on the interior slope of the dike where it will dry and provide convenient material for dike improvement.

After the dredged material in the containment area has dried sufficiently to support equipment (often 3 to 6 months after disposal), interior trenches

should be constructed throughout the containment area. These should be connected to the perimeter trench system to provide rapid movement of water to the weir and out of the site. A consistent grade must be maintained throughout the trench network, and the trench junctions must be clear of blockages (Benson 1988, Poindexter and Walker 1988).

The pattern of interior trenches should be adapted to the geometry of the disposal area. In rectangular areas, parallel trenches running the length of the disposal site are often used; these trenches are then connected to the perimeter trench along the side adjacent to the weir. In irregularly shaped containment areas, a pattern of trenches radiating out from the weir(s) can be used effectively. In any case, the trench pattern should provide efficient drainage of all parts of the disposal site. Trenches are often constructed on 200-ft centers; closer spacing would provide better drainage, but economics and equipment operation within the site often preclude closer trench spacing.

Many types of equipment, including conventional equipment, such as backhoes, draglines, and mini-excavators, have been used successfully to construct interior trenches. However, in the early stages of dewatering, this equipment must often work on mats to reduce the ground contact pressure, even though low ground-pressure equipment is usually used. The most expedient method of interior trench construction uses a rotary ditcher pulled by either a tracked or large rubber-tired vehicle (Poindexter 1989). In addition to the speed of trenching, an advantage of this type of equipment is that it trenches continuously as it moves across the containment area. Thus there are often fewer problems with equipment mobility than there are with equipment (e.g., draglines) which must work from one location for a period of time.

Removal of material

Removal of material from the interior of the disposal site will further increase storage capacity and useful life. Coarse-grained material can usually be removed immediately after the ponded water has been decanted, although this material must have drained sufficiently to prevent a quick condition when equipment begins to operate. Conventional earthmoving equipment, such as bulldozers and front-end loaders, is generally used to remove this material which is often used for dike raising and improvement. In some cases, a market for the material

may exist and it may be sold. However, the ownership of the dredged material must first be established, and appropriate legal procedures for sale must be followed.

After a successful dewatering effort, dried fine-grained material can be removed from the containment area. When sufficient crust thickness has developed, the dried material (crust) can be scraped from the surface of the deposit. Bulldozers are often used to windrow the dried material, which is then collected by pans and moved to the dikes or haul roads for their improvement. In some instances, this fine-grained material may have other productive uses, although the grain size may limit its applications.

Individual Site Management

The general management principles discussed above should be implemented for individual containment areas regardless of size. When only one containment area is available for use during an entire dredging project, typically its area is large, consisting of several hundred acres or more, and it is normally used frequently.

Large containment areas, especially those used almost continuously, are difficult to manage to allow time for effective drying of dredged material. However, dividing a large site into several compartments can facilitate management. Each compartment can be managed separately so that while some compartments are being filled, others can be dewatered (Palermo, Shields, and Hayes 1981). For example, the 2,500-acre Craney Island disposal facility in Norfolk District was subdivided into three compartments in 1984 to permit more effective management of the site (Figure 3).

The recommended management scheme for large compartmentalized containment areas involves sequential placement of thin lifts of dredged material into each compartment, as shown in Figure 4. The functional sequence for each compartment consists of dredged material placement, settling and surface drainage, dewatering, and dike raising (often using dewatered dredged material). The operation must be designed to include enough compartments to ensure that each thin lift is dried before the subsequent lift is placed.

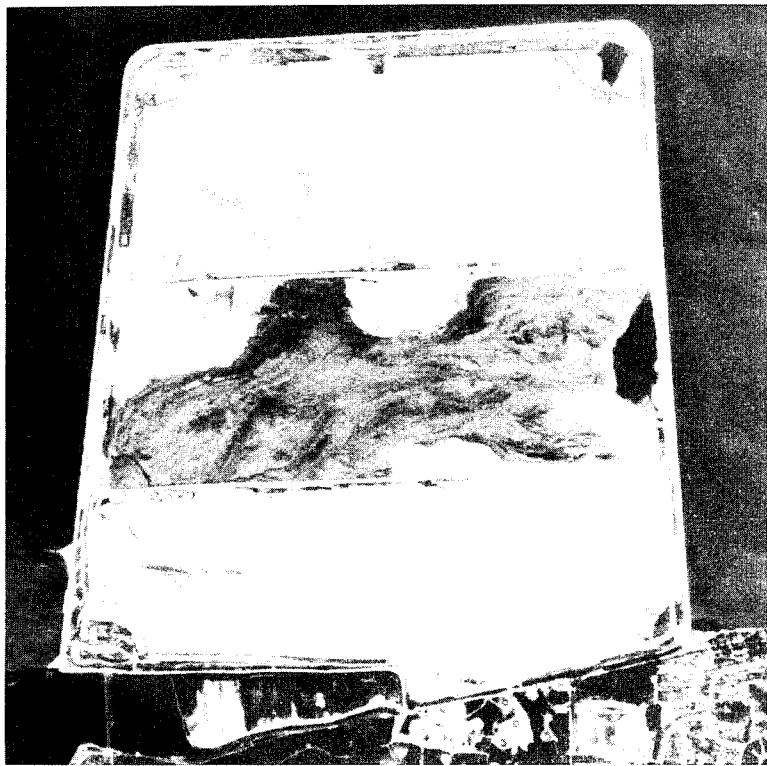


Figure 3. Craney Island facility

Multiple Site Management

Multiple disposal site management practices are similar to those for large compartmentalized containment areas. Sequenced disposal activities should be used to allow maximum drying of the dredged material between disposal operations. If several of the containment areas must be used during one dredging operation, the quantity of dredged material to be placed in each site should be proportioned according to surface area of the sites involved. This will ensure that the thinnest lift possible is placed in each containment area. By following these practices, the maximum benefit will be gained from evaporative drying and thus the maximum capacity of each site will be realized.

Assessing Site Capacity

Computational tools are available to assist with various aspects of dredged

LEGEND

- a - DISPOSAL
- b - DEWATERING INITIATED
- c - DEWATERING COMPLETED
- d - REMOVAL OF DRY MATERIAL/
DIKE RISING

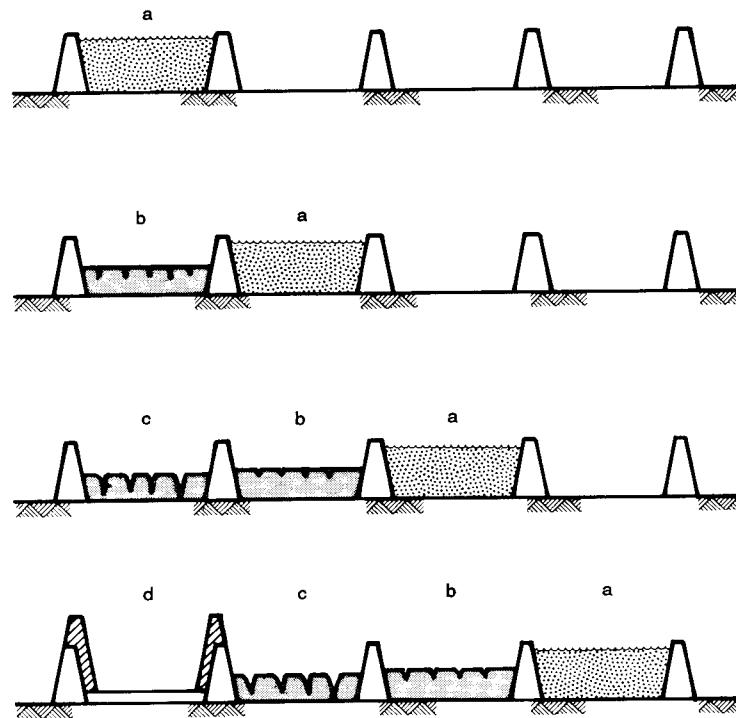


Figure 4. Conceptual dewatering operations for compartmentalized disposal sites

material containment area management. A finite strain consolidation and desiccation computer program entitled "Primary Consolidation and Desiccation of Dredged Fill (PCDDF)" is available (Poindexter-Rollings and Stark in preparation, Benson 1987, and Cargill 1985) to assess the storage capacity and service life of individual containment areas. Another program, D2M2, can be used to optimize use of multiple disposal sites; it is available through the US Army Corps of Engineers' Hydrologic Engineering Center (Ford 1984) and through the US Army Engineer Waterways Experiment System (ADDAMS) (Schroeder 1988).

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